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SEEDLING PECANS BUDDED BY NEW METHOD.

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B. T. GALLOWAY, *Chief of Bureau.*

BUDDING THE PECAN.

BY

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SEED AND PLANT INTRODUCTION AND DISTRIBUTION.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief.
Washington, D. C., October 15, 1902.

Sir: I have the honor to transmit herewith a paper by Mr. George W. Oliver, Expert in the Office of Seed and Plant Introduction and Distribution, on "Budding the Pecan." Owing to the increased interest in nut culture in this country Mr. Oliver's method of rapidly propagating the pecan by budding is worthy of careful attention, and I respectfully recommend that the paper be published as a bulletin of the regular series of this Bureau.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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BUDDING THE PECAN.

DIFFICULTIES ENCOUNTERED IN PECAN BUDDING.

The propagation of the pecan has hitherto been one of the principal drawbacks to the successful cultivation of this nut tree. According to the published experiences of growers who have given attention to propagation by budding and grafting, the percentage of successful unions in the total number of plants worked has been small. Although the young budded or grafted trees are sold at very high prices, the work is unremunerative from the nurseryman's point of view. Much of the work of pecan propagation has doubtless been along similar lines to those favorable to the propagation of well-understood subjects, such as the apple, peach, and other fruit trees. Consequently the pecan has earned the reputation of being difficult to work on stocks of the same or allied species. This is not to be wondered at, as mistakes are very easily made in the selection of working material, time of operating, etc. The writer is convinced, however, that if budding be performed as herein described the pecan will reward the careful operator with a high percentage of unions.

The principal trouble encountered in pecan budding is undoubtedly due to the selection of wrong material from the tree to be propagated. By the methods usually adopted a success not above the average was attained, and it is easy to understand why small trees budded from choice varieties can not be sold at less than from $1 to $3 each. By the use of a method which has been devised for budding the pecan and the selection of 1-year-old buds the outlook is good for very successful propagation. It will be seen where some of the trouble lies if the budding of the peach is compared with that of the pecan. In the case of the former a shoot of the current year's growth will by the latter part of August give a very large number of buds which can be worked successfully. This is not the case with the pecan. True, a number of likely looking buds are formed on a shoot of the current season, but by the method of budding in use at present not many of the buds on a shoot are used. Two or three at the base are generally selected, but, as will be explained later, there is great danger of unsatisfactory results through using even the best of these buds.

WHY THE PECAN SHOULD BE BUDDED.

In the pecan region of the Southern States there are at least fifty named varieties, nearly all of which are well worthy of perpetuation on account of the large size and fine flavor of the nuts. These choice varieties of the pecan are as yet but little known, owing to the very small number of trees in cultivation. In the course of time, however, as they are more widely grown, they will become the most prized of all the nuts for domestic use, and it is probable that when the supply is large enough they will be preferred abroad to the best Persian walnuts. The nuts of the choicer varieties of pecan, owing to the supposed difficulty of bud propagation, are much in demand at fancy prices for the purpose of raising young plants. It has been ascertained, however, that seedlings from nuts of the choice varieties do not come true, resembling in this particular many of our popular fruit trees. Many of these seedling pecans bear nuts not much superior to the common wild forms. With the knowledge now acquired as to the liability of varieties to vary in their seedlings through the agency of cross fertilization, it would indeed be remarkable were the seedlings to produce nuts equal in size and flavor to those of the mother tree. The chance trees which bear large nuts are found wild in widely different parts of the South. The nuts from these trees are much above the average not only in point of size, but also on account of other desirable qualities. Being peculiarly situated, and as they can not depend wholly upon their own pollen to aid in the reproduction from seed, there is nothing to prevent pollen from undesirable forms gaining access to the pistillate flowers, thus securing a reduction of the size or a decrease in the flavor of the nuts borne by the seedlings. After waiting several years for the seedling trees to bear, this naturally causes the grower a good deal of disappointment. So, necessarily, as with apples, peaches, and other fruits, the only way in which the choice varieties of the pecan can with certainty be perpetuated in a manner to permit of being handled by dealers, is by budding or grafting on seedling stocks.

RAISING SEEDLING STOCKS.

Up to the present time it has not been demonstrated that there is a better stock for the reception of buds or grafts of the pecan than seedling stocks of the same species. In raising pecan seedlings for stocks it is advisable to select seeds from trees at the northern limit of the pecan belt, because, while seedlings from that section will thrive throughout the belt, those from the extreme south can not be expected to prove as hardy and thrifty at the northern limit as those trees which are growing wild in that section.

The seed nuts should be secured as early as possible after they are ripe, so as to make certain of preventing loss through drying out.

Stratification should be begun late in the fall. For this purpose it is most convenient to use boxes, say, 3 feet long, 1 foot wide, and 3 inches deep. A mixture of sand and ashes in about equal proportions is a good medium in which to imbed the nuts. A layer of this material 1 inch thick should be placed in the bottom of a box, then a layer of pecans as close together as possible. It is not advisable to put more than a single layer in a box, because of the brittle nature of the root, the nuts being somewhat irregular in sprouting. Each box is then filled with the sand and ashes, and all the boxes used should be piled together to a convenient height. They should occupy a sheltered position out of doors, and be covered with a considerable thickness of straw, mats, or old sacking until the nuts show signs of germinating, which will usually occur toward the end of April. To give facilities for inserting the buds on the north side of the seedling stocks, the nuts are then planted in rows running east and west. The rows should be 3 feet apart and the nuts placed 5 inches apart in the row. It is not possible the first season to raise seedlings which are large enough to be used as stocks, but in order to secure a good, stout growth, so as to have them large enough for working the second season, the soil should be deeply worked with a plow, rolled and, when necessary, harrowed several times until it is well pulverized. The remaining part of the work must be done by hand.

The position to be occupied by the seedlings is marked by the aid of a stick with a notch cut in one end. This is run along the line, leaving a well-defined mark in the soil. With a spade a trench is dug about 5 inches deep. In the bottom of the trench about 2 inches of equal parts of leaf soil and sand are placed. The nuts are carefully laid on this. In planting those which have the root developed to a length of more than 1 inch, a hole is made in the soil with the fingers and the root placed in it. If the soil be dry, water is given. Fine soil is then raked level over the nuts and slightly firmed with the end of the rake. The operation is finished by a mulch of 1 inch half-rotted leaves, cut cornstalks, or other material. This prevents baking of the soil after rains and supplies a surface which is easily pierced by the sprouts. The nuts thus treated should germinate very evenly, and at the close of the first season should show a stem above ground of about 12 inches in length. Many of the seedlings will attain a thickness of three-eighths of an inch close to the ground. The taproot will average fully 2½ feet in length and will be supplied with quite a number of very small fibrous roots. By the middle of the following June the seedlings will average over half an inch in diameter near the ground, making excellent stocks for budding.

SELECTION OF DORMANT BUDS.

After a series of trials with buds of the current season's growth and those of the preceding season, none but those which were formed

during the season preceding the operation of budding are recommended for use. The dormant buds (Pl. I, fig. 1, A) during the month of June are ready to burst into active growth when given the slightest encouragement. Moreover, they can be very easily removed from the bud stick, together with a section of thick, solid bark. The bark on the old wood can be handled without being injured in any way, and it is in every particular splendidly adapted for successful work. After the union has taken place and the stocks are cut back, the bud will give a stronger growth and attain a greater length than growths from the current season's buds. In using buds from the current season's wood (Pl. I, fig. 1, B) many difficulties will be encountered, and the results will be found disappointing. Until the season is pretty well advanced the current year's bark is very thin and more or less succulent, and it can not be removed from the wood without being bruised. Sometimes, even when the greatest care is exercised by the operator, it will split lengthwise and be rendered useless. Again, especially up to the latter part of July, the cuticle is very apt to peel, and where it does stay on it is almost certain to be bruised in the operation of tying. Another serious objection is the presence of the leaf stalk. This, shortly after the bud is inserted, will shrivel up and fall, or it can easily be detached; but the scar left, which in most cases is a large one, is, it is thought, the channel through which a large part of the sap of the bark is lost before it has had an opportunity to unite with the cambium of the stock.

LOCATION OF THE BUDS.

It is important that the position which the dormant buds occupy on the branches be accurately understood, so that the proper ones may be selected for the work of budding. They are to be found on the branches made the year preceding that in which it is desired to insert the buds. The pecan trees which have been examined in the vicinity of Washington show exceedingly few growths from terminal buds. The growth of a season starts from one of the large axillary buds near the apex of the preceding year's growth (Pl. I, fig. 2, A). Two or more of these buds may produce growths, but commonly only one. In fruiting branches the nut cluster takes the place of the terminal bud on the young wood, as seen in Pl. II, fig. 1. The strong shoots from these axillary buds when 1 year old are the ones which give good material for budding. Each bud will be found immediately above a leaf scar of the preceding season (Pl. I, fig. 1, A). Those buds which are nearest the base of the shoot are the smallest and firmest; consequently they are the best fitted for the work. Regarding the period during which buds retain their power of bursting into active growth, Pl. II, fig. 2, shows a 7-year-old branch of an allied species of hickory (*Hicoria laciniosa*) with three small growths from

dormant buds made during the present season, together with a bud quite dormant and evidently able to persist for some time. In the selection of bud wood it is preferable to cut the branches from the tree to be propagated in the early part of the day, choosing shoots as large in diameter as possible and those which show the greatest number of short, plump buds. Immediately on severing the branches from the tree the growth of the current season is severed and discarded, and the 1-year-old bud sticks are wrapped in dampened newspapers. If necessary, they can in this manner be kept for several days without danger of drying out.

EXPERIMENTS WITH BUDS OF THE CURRENT SEASON.

In a recent series of budding experiments with the current season's buds the work began June 6. The buds selected were principally the small, plump ones found at the base of the soft wood (Pl. I, fig. 1, B). At that date the buds were slightly immature; consequently, when a large section of bark was removed from the wood it showed signs of injury. The cuticle peeled easily, and even with great care in removing buds with sections of bark attached and in placing and tying them in position, the percentage of unions was small. Up to the end of July separate lots of the current year's buds were worked at intervals of one week, the percentage of unions increasing slightly with each week. Patch budding (Pl. III, fig. 1), which is merely a modification of annular budding, was the method used. Taking everything into consideration, the results obtained could by no means be considered satisfactory.

AN IMPROVED METHOD OF BUDDING.

An improved method, which has been demonstrated to be a perfect way in which to bud the pecan and one by the use of which there are very few failures, is as follows: For the reception of the bud make two transverse cuts in the bark of the seedling stock (Pl. III, fig. 2) a few inches above the ground line, these two cuts, about 1 inch apart, to be connected by a longitudinal incision. The bark at each side of the longitudinal cut is then raised far enough (Pl. III, fig. 3) to admit of the insertion of the section of bark on which the bud is situated (Pl. III, fig. 2, A). The rectangular section of bark when prepared for insertion must be of exactly the same length as the cut in the stock. It is taken from the stick of buds by making two transverse cuts through the bark at equal distances from the bud. Two longitudinal cuts are then made through the bark, leaving the bud in the center of the patch, which should be a little over 1 inch long and five-eighths of an inch wide. The patch must be raised carefully from the bud stick to guard against breaking and with as little bending during the operation as possible. When the operator finds that he does not

succeed at the first trial, it will be advisable to practice for a time on wood which is of no value. The stick of buds should be grasped firmly in the left hand, with the knife held by the fingers of the right, the thumb resting on the bud stick. Insert the point of the knife at one end of one of the longitudinal cuts, pressing the blade toward the thumb; this pressure will start the bark. Next insert the end of the handle of the knife, gradually removing the section. The patch is prepared for insertion by first cutting the two ends as straight as possible, using a very sharp knife. The outer bark at the sides (Pl. III, fig. 2, A) is then shaved off, so that the edges will make a perfect fit when under the bark of the stock (Pl. IV, fig. 1). When the bud is securely in place, the two wings of bark on the stock are bound firmly over the bud section with raffia (Pl. IV, fig. 2), and, as a preventive against the admission of water during the process of uniting, a little soft grafting wax may be smeared across the upper transverse cut and the whole wrapped with a narrow strip of waxed cloth (Pl. IV, fig. 3). The wrapping should be started at the bottom, each wrap being half covered by the succeeding one; this will effectually keep out moisture during wet weather. As a protection against the heat of the sun, strips of paper, 8 inches long by 6 inches wide, should be tied around the stem of the stock an inch or two above the bud, but covering it (Pl. V, fig. 1), allowing the bottom part to remain open. After the sixth day the paper covering should be removed, and after the tenth day the waxed cloth may be taken off. By the fifteenth day the buds will have united sufficiently to allow of the removal of the raffia. This method of budding will be found to give an exceedingly satisfactory union. Experience has shown that with carefully selected buds from 1-year-old wood and healthy, vigorous growing seedling stocks, every section of bark will unite.

OTHER METHODS OF BUDDING.

Sometimes, when the seedling stocks are small and the size of the section of bark necessary for the union will more than cover half of the circumference of the stem of the stock, a quick growth on the part of the stock will produce a swelling immediately above the upper transverse cut in the bark. This can be averted by the use of a triangular patch bud (Pl. V, fig. 2), with one of the angles pointing upward. In using this method care must be taken that the three sides of the bud section should exactly fit the sides of the space prepared for them. It will be found advisable to smear a small quantity of soft grafting wax over the cut parts after the bud is in position and before tying with raffia. This makes an exceedingly neat union and is best used with small buds. Large ones need a larger section of bark attached.

In patch budding (Pl. III, fig. 1) a rectangular piece of bark, similar in size to that given in Pl. III, fig. 2, is taken from the bud stick. A

corresponding piece is removed from the stock and the section from the bud stick carefully fitted in its place. It is then tied with a strand of dampened raffia, but this is used only to keep the bud firmly in place; the top and bottom of the section are left uncovered, because there is a danger of the raffia injuring the cut ends, which are held tightly in place by narrow strips of waxed cloth covering all but the bud. A wrapping of paper is then given, as already described. The principal objection to this method of budding is that the sides of the bark are apt to rise somewhat during the growth of the stock. This, while in no way injuring or retarding the growth of the bud, does not have a very neat appearance for some time after the union is effected and may have a tendency to weaken the point of union, besides giving opportunities for harboring noxious insects.

STARTING BUDS INTO GROWTH.

It is desirable that the buds be started into growth as soon as possible after it has been ascertained that the union has taken place. Buds which are united to stocks having a large section of bark attached are liable to have more or less of the bark decay during the winter months. This occurs principally with young buds, especially when they are worked on 1-year-old wood. This would seem to be common to all the species of the hickory family, but where 1-year-old buds are used the danger is lessened considerably. However, in the latter case they lose their vigor in proportion to the time they remain on the stock without being encouraged to break.

In order to force the bud into growth it is necessary that the top of the seedling stock be removed, leaving only one or two healthy leaves at the base of the present season's growth. In a few days the buds in the axils of these leaves will push out, and they should be removed as soon as they can be handled, and on down the stem the small dormant buds formed in the axils of the leaves of the preceding season will burst into active growth and must be rubbed off at once. By this time the scion bud will have swollen considerably, and in a month's time it will have developed several full-sized leaves. With buds inserted up to the end of June there is abundant time for the development of a good-sized shoot. The terminal buds of these shoots reach maturity in the majority of cases, but this is of little consequence, as one of the lateral buds will push out strongly the following spring.

The practice of tying the growth of the scion to the top of the stock is a good one; it not only saves the soft growth from being whipped about by the wind, but it also secures a close, upright growth. At the beginning of the second season all of that part of the stock which is above the union should be carefully removed, not with a pair of pruning shears, but with a sharp knife, so as to leave a cleanly cut surface, with the bark uninjured. The cut surface should be covered with melted grafting wax to prevent decay.

TRANSPLANTING BUDDED TREES.

The pecan is usually regarded as a difficult subject to deal with in transplanting. A large percentage of the trees die back after being placed in their permanent positions from nursery rows. However, if certain precautions be observed it will be found that there is no ground for the supposed difficulty, as the pecan will withstand the ordeal of transplanting in a young state quite as well as any other forest tree. In transplanting the pecan its requirements must be carefully considered. In a young state it is a very deep-rooting subject, and any attempt to change its nature by coaxing the roots to grow near the surface of the soil will end disastrously.

Pl. VII shows part of a row of 3-year-old budded trees, which were planted during the spring of 1902, after being out of the ground for several weeks. In this row there are about 40 plants, and only one of them shows signs of poor health. The work of removing these trees from nursery rows was evidently carried out with no more care than is ordinarily bestowed on young forest trees, except that a fairly successful attempt was made to save as many roots as possible. A few of the large roots were mutilated, and during a journey of a week or more from the nurseries the roots became dry. The mutilated roots were pruned and the cut surfaces covered with melted grafting wax to prevent decay. They have been treated since coming to the nursery of the U. S. Department of Agriculture as described below, and the result is a lot of young trees with new growths in every way satisfactory.

To insure the growth of the trees after transplanting, it is very necessary to avoid excessive trimming of the branches and roots. There must be at least one healthy undisturbed shoot of the previous season left on the plant untouched, because the large, plump axillary buds near the tip of the shoot will come into leaf with greater certainty and more quickly than will older buds on cut-back growths. Especially is this the case after the tree has undergone removal, involving the tremendous disturbance of the root system, which almost completely robs the plant for the time being of its water supply. Seedlings in nursery rows with undisturbed roots, when trimmed down to the small lateral buds on 1 or 2-year-old wood, will start as readily, if not as strongly, as the buds near the end of the most recent growth. It must be remembered that the terminal buds of the pecan very seldom grow. They sometimes do so in seedlings, but very seldom after a certain age. This is shown in Pl. I, fig. 2, Pl. II, fig. 1, and Pl. VI, which represent the growths made during three seasons. In Pl. I, fig. 2, the large, plump bud near the terminal contains the flowering branch. The branch shown in Pl. II, fig. 1, is developed from this bud. Pl. VI shows a still further development. The small, dead stump between the two living shoots represents the position occupied

by the nuts the preceding year, while the two shoots are from two of the large buds near the nut. (Pl. II, fig. 1.)

In transplanting young trees, especially those which are to a certain extent weakened by the operation of budding, it is impossible to save all of the lateral roots during the operation of digging from the seed rows. It is, however, very desirable that as few as possible be sacrificed. Very careful lifting will pay for the extra labor. In seedling trees the taproot is usually severed much too near the collar and at too early a stage. It must be allowed to grow the first and second seasons if the seedlings are to be budded, because when removed at the end of the first season or the beginning of the second the weak growth will render it impossible to perform any budding operations during that year. Therefore, it is not till the third year that the taproot can be interfered with, but it is well not to risk touching it until the growth of that season is completed, for the reason that although the shoot made from the inserted bud makes considerable growth the same season it is put on, it will make very large growth the season following. The budded seedlings will then bear removal. They may have a small part of the taproot removed and be either planted permanently or in nursery rows. The budded seedlings of the present day, if the variety be a good one, are retailed at about $2.50 apiece. When the tree brings that amount—and the supply is understood to be far short of the demand—it should be furnished with good roots. If it is worth that sum to the purchaser, it is certainly entitled to a little further expenditure of time and care in the preparation of suitable conditions under which to grow. The retention of roots at least 2½ feet below the surface of the soil is desirable. If the ground in which the young trees are to be placed is not composed of good soil to that depth, it should be supplied. A good start the first year after planting means everything to the future tree; a bad start will, in the majority of cases, mean a sickly tree for a long time and an unprofitable investment in the end. With the roots deep in good, light, loamy soil the tree is to a certain extent independent of moisture from the surface. When growth begins in earnest, the roots will grow in the direction of the food supply. The severance of a large portion of the taproot saves a good deal of labor in digging and planting, but it means a complete defeat of nature's method in supplying the wants of the tree. Anyone who tries the two methods and compares the results will be convinced in one season in favor of large roots.

As a further precaution, the roots should be plunged in liquid mud the moment they are free from the soil and never be exposed for a minute longer than is necessary, as they too often are, to the drying influence of the air. After taking from the mud, the roots should be

wrapped in damp sacking, moss, or any other material which will hold moisture, and kept in this condition until they are about to be planted. They should then be again plunged in liquid mud, and while this is hanging to the roots they should be planted. When the soil has been well firmed about the roots of the tree and the hole is about two-thirds filled with soil, the remaining space should be filled with water. When this has disappeared, fill in the rest of the soil. A mulch of short grass, stable litter, or half-decayed leaves left on during the summer will supply favorable conditions. If these little details are faithfully attended to there is little danger that unsuccessful results will follow. A little extra expense is involved at first, but careless handling will be far more costly in the end.

PLATES.

DESCRIPTION OF PLATES.

FRONTISPIECE. Part of row of seedlings budded by new method on June 26, 1902; photographed August 15, 1902.

PLATE I. Fig. 1.—Branch of pecan, showing growth of two seasons, with old and new buds. A, 1-year-old dormant buds; B, current season's buds; C, small plump buds at base of growth, from which the leaves fall early. Fig. 2.—Twig of pecan; top part of season's growth, showing buds during winter; A, flower bud; B, terminal bud.

II. Fig. 1.—Fruiting branch of pecan, developed from bud shown in Plate I, fig. 2, A. A, buds from which the growth of the following season is developed, the buds, B, remaining dormant. Fig. 2.—Seven-year-old branch of *Hicoria luciniosa*. A, growth made from buds which stayed dormant during seven years; B, dormant bud in good condition.

III. Fig. 1.—Patch budding. Two-year-old seedling pecan with piece of bark removed. A, bud with section of bark attached, ready to be fitted on stock. Fig. 2.—Seedling pecan stock, showing incisions made in the bark with a knife previous to lifting the bark; A, bud with section of bark which has the sides shaved down, ready to be inserted under the bark of the stock. Fig. 3.—Seedling pecan stock, with bark raised and ready for bud to be inserted.

IV. Fig. 1.—Seedling pecan stock, showing bud in position ready to be tied. Fig. 2.—Budded seedling pecan, the wings of bark on the stock almost covering the bud section. Both are held securely in position while the union is being accomplished. Fig. 3.—Budded seedling pecan, showing the method by which the narrow strip of waxed cloth should be applied.

V. Fig. 1.—Seedling pecan budded, showing how the paper covering should be fastened for protection from sun. Fig. 2.—Triangular budding. Seedling pecan, with triangular section of bark removed; A, bud of variety to be propagated ready to insert in stock.

VI. Branch of pecan, showing shoots made from buds near the base of the nut cluster, as seen in Plate II, fig. 1, A; A, position occupied by nut cluster during preceding year.

VII. Three-year-old budded trees transplanted during March, 1902; photographed August 15, 1902.

O

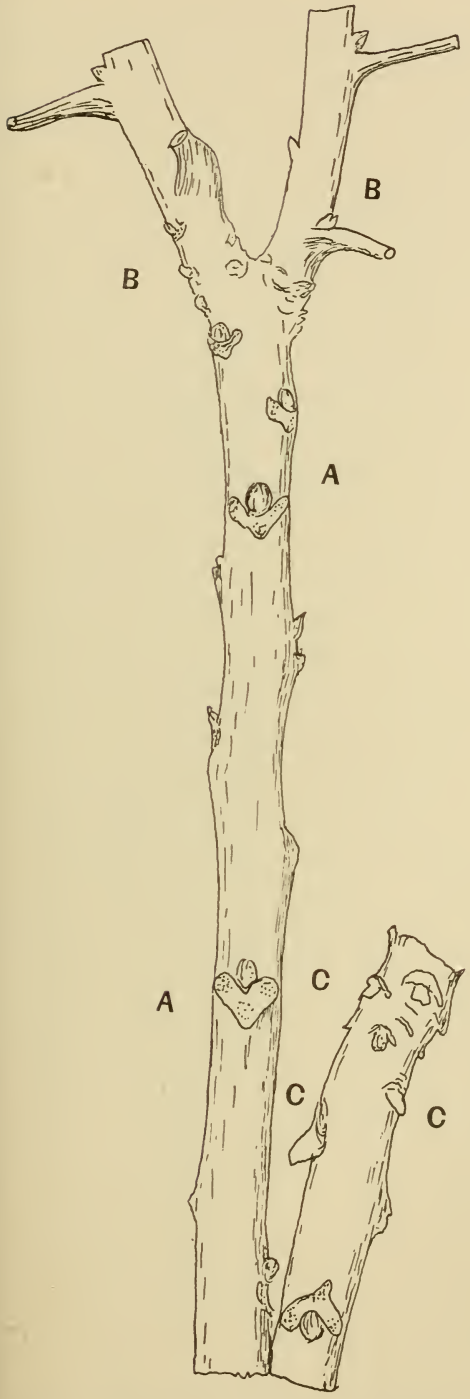

FIG. 1.—PECAN BRANCH—SUMMER CONDITION.

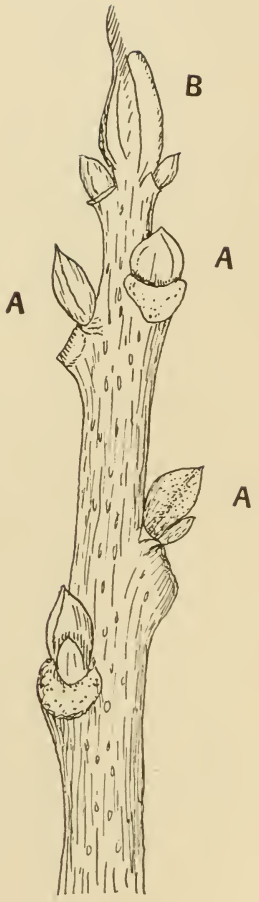

FIG. 2.—PECAN BRANCH—WINTER CONDITION.

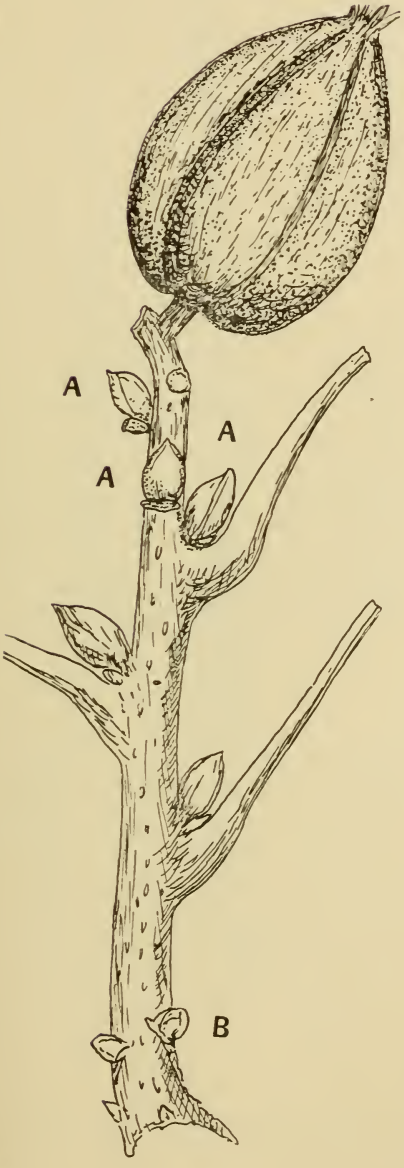

FIG. 1.—PECAN BRANCH—FRUITING CONDITION.

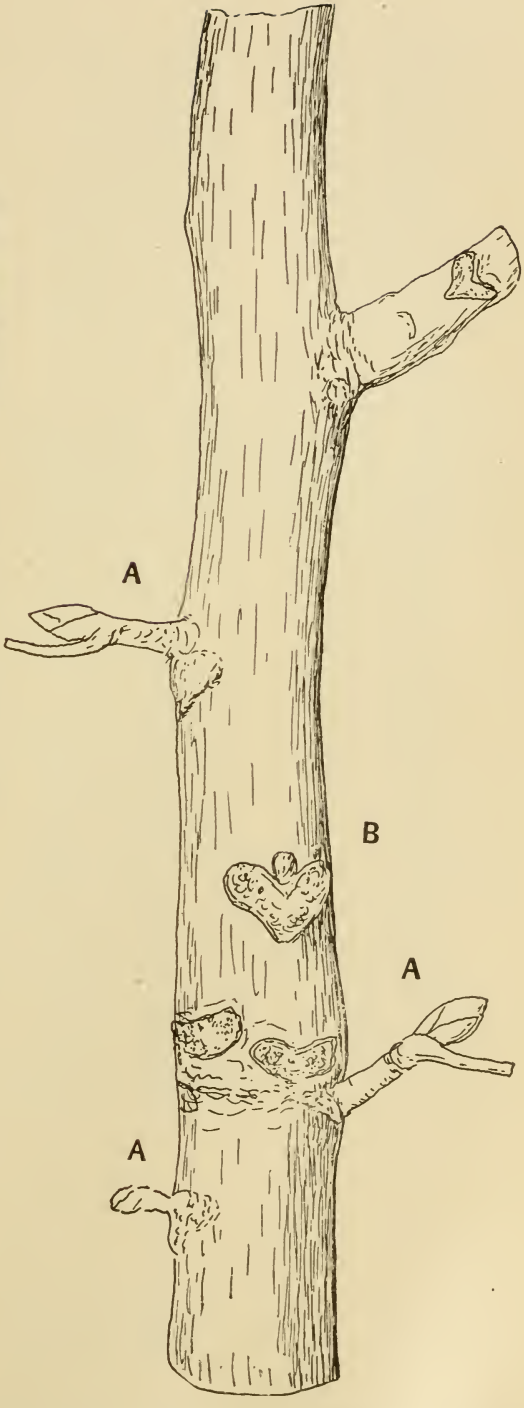

FIG. 2.—SEVEN-YEAR-OLD BRANCH OF HICORIA LACINIOSA.

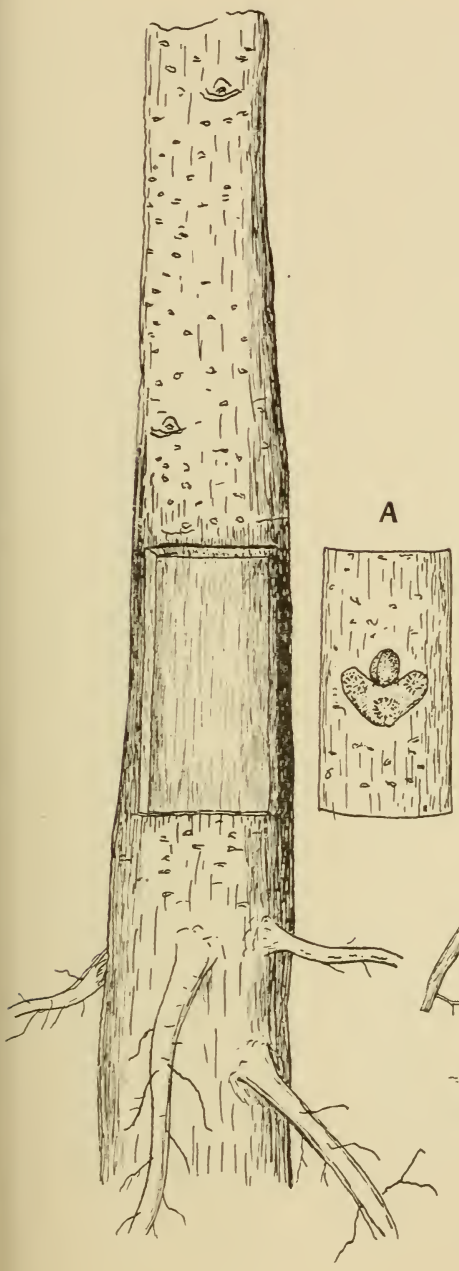

FIG. 1.—PATCH BUDDING. BUD READY FOR INSERTION.

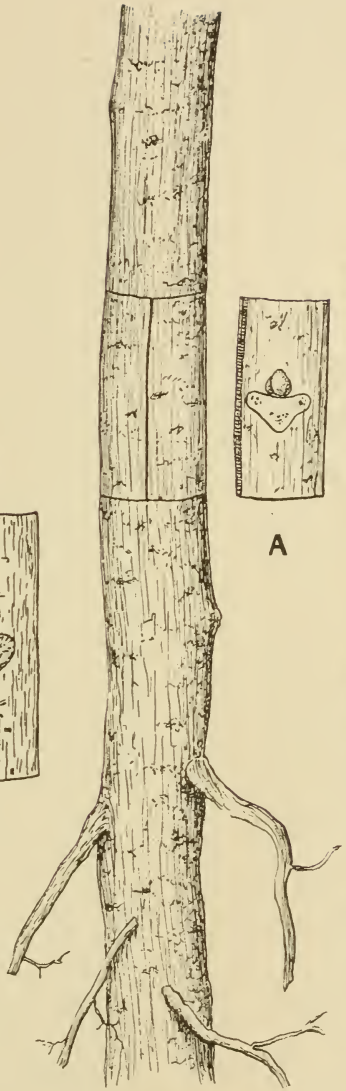

FIG. 2.—SEEDLING PECAN STOCK. PRELIMINARY INCISIONS IN BARK.

FIG. 3.—SEEDLING PECAN STOCK. BARK RAISED READY FOR BUD.

FIG. 1.—SEEDLING PECAN STOCK. BUD INSERTED READY TO BE TIED.

FIG. 2.—BUDDED SEEDLING PECAN. BUD INSERTED AND TIED.

FIG. 3.—BUDDED SEEDLING PECAN. BUD WRAPPED WITH WAXED CLOTH.

FIG. 1.—BUDDED SEEDLING PECAN, COVERED WITH PAPER

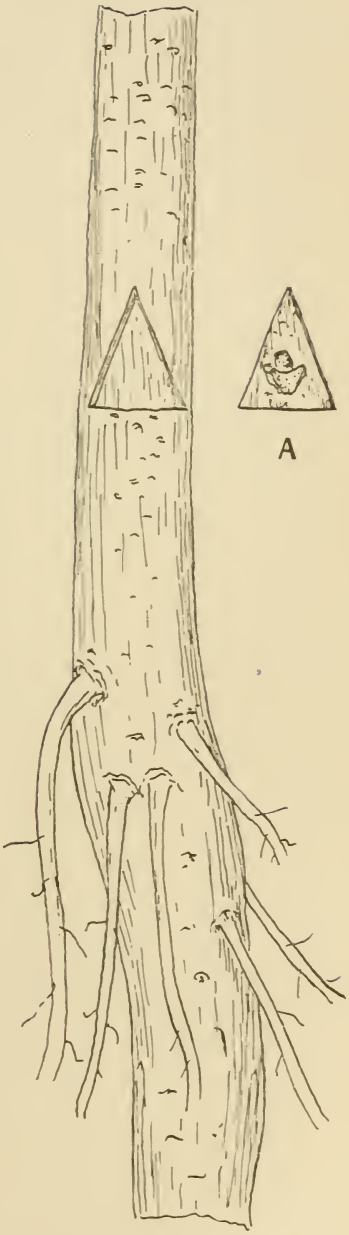

FIG. 2.—TRIANGULAR BUDDING. BUD READY FOR INSERTION.

BRANCH OF PECAN, SHOWING SHOOTS FROM BUDS NEAR NUT CLUSTER OF PREVIOUS SEASON.

THREE-YEAR-OLD BUDDED PECAN TREES RECENTLY TRANSPLANTED.